

APPARATUS AND METHOD OF DRIVING PLASMA DISPLAY PANEL

Technical Field

5 This invention relates to a plasma display panel, and more particularly to an apparatus and method of driving a plasma display panel that is adaptive for reducing power consumption.

10 Background Art

 Generally, a plasma display panel (PDP) displays a picture by utilizing a visible light emitted from a phosphorus material when an ultraviolet ray generated by a
15 gas discharge excites the phosphorus material. The PDP has advantages in that it has a thinner thickness and a lighter weight in comparison to the existent cathode ray tube (CRT) and is capable of realizing a high resolution and a large-scale screen.

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 Referring to Fig. 1 and Fig. 2, a conventional three-electrode, AC surface-discharge PDP includes scan electrodes Y1 to Yn and sustain electrodes Z provided on an

upper substrate 10, and address electrodes X1 to Xm provided on a lower substrate 18. Discharge cells 1 of the PDP are provided at intersections among the scan electrodes Y1 to Yn, the sustain electrodes Z and the address electrodes X1 to Xm.

Each of the scan electrodes Y1 to Yn and the sustain electrodes Z includes a transparent electrode 12, and a metal bus electrode 11 having a smaller line width than the transparent electrode 12 and provided at one edge of the transparent electrode 12. The transparent electrode 12 is usually formed from indium-tin-oxide (ITO) on the upper substrate 10. The metal bus electrode 11 is usually formed from a metal on the transparent electrode 12 to thereby reduce a voltage drop caused by the transparent electrode 12 having a high resistance. On the upper substrate 10 provided with the scan electrodes Y1 to Yn and the sustain electrodes Z, an upper dielectric layer 13 and a protective film 14 are disposed. Wall charges generated upon plasma discharge are accumulated onto the upper dielectric layer 13. The protective film 14 protects the electrodes Y1 to Yn and Z from a sputtering generated upon plasma discharge, and enhances an emission efficiency of secondary electrons. This protective film 14 is usually made from magnesium oxide (MgO).

The address electrodes X1 to Xm are formed on a lower substrate 18 in a direction crossing the scan electrodes Y1 to Yn and the sustain electrodes. A lower dielectric layer 17 and barrier ribs 15 are formed on the lower substrate 18. A phosphorous material layer 16 is formed on the surfaces of the lower dielectric layer 17 and the barrier ribs 15. The barrier ribs 15 are formed in a stripe or lattice shape to physically divide the discharge cells 1, thereby shutting off electrical and optical interferences between the adjacent discharge cells 1. The phosphorous material layer 16 is excited and radiated by an ultraviolet ray generated during the plasma discharge to generate any one of red, green and blue visible light rays.

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An inactive mixture gas, such as He+Xe, Ne+Xe or He+Ne+Xe, for a discharge is injected into a discharge space defined between the upper/lower substrates 10 and 18 and the barrier ribs 15.

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Such a PDP makes a time-divisional driving of one frame, which is divided into various sub-fields having a different light-emission frequency, so as to express gray levels of a picture. Each sub-field is again divided into a reset period for uniformly causing a discharge, an address

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period for selecting a discharge cell and a sustain period for realizing the gray levels depending on the discharge frequency. For instance, when it is intended to display a picture of 256 gray levels, a frame interval equal to 1/60 second (i.e. 16.67 msec) is divided into 8 sub-fields. Each of the 8 sub-fields is again divided into an address period and a sustain period. Herein, the reset period and the address period of each sub-field are equal every sub-field, whereas the sustain period and the discharge frequency are increased at a ration of 2^n (wherein $n = 0, 1, 2, 3, 4, 5, 6$ and 7) at each sub-field in proportion to the number of sustaining pulses. As the sustain period is differentiated at each sub-field as mentioned above, gray levels of a picture can be implemented.

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Fig. 3 schematically shows a driving apparatus for the PDP.

Referring to Fig. 3, the driving apparatus for the PDP includes a gain adjuster 32, an error diffuser 33 and a sub-field mapping unit 34 connected between a first inverse gamma adjuster 31A and a data aligner 35, and an average picture level (APL) calculator 36 connected between a second inverse gamma adjuster 31B and a waveform generator 37.

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Each of the first and second inverse gamma adjusters 31A and 31B makes an inverse gamma correction of digital video data RGB from an input line 30 to thereby linearly
5 convert brightness according to gray level values of image signals.

The gain adjuster 32 adjusts an effective gain for each of red, green and blue data to thereby compensate for
10 a color temperature.

The error diffuser 33 diffuses a quantization error of the digital video data RGB inputted from the gain adjuster 32 into the adjacent cells to thereby make a fine control
15 of a brightness value.

The sub-field mapping unit 34 maps a data from the error diffuser 33 onto a sub-field pattern stored in advance for each bit and applies the mapped data to the
20 data aligner 35.

The data aligner 35 applies digital video data inputted from the sub-field mapping unit 34 to a data driving circuit of the PDP 38. The data driving circuit is
25 connected to the data electrodes of the PDP 38 to latch a

data from the data aligner 35 for each one horizontal line and then apply the latched data to the data electrodes of the PDP 38 for each one horizontal period.

5 The APL calculator 36 calculates an average brightness per frame of digital video data RGB inputted from the second inverse gamma adjuster 31B, that is, an average picture level (APL), and outputs information about the number of sustaining pulses corresponding to the calculated
10 APL.

 The waveform generator 37 generates a timing control signal in response to the information about the number of sustaining pulses from the APL calculator 36, and applies
15 the timing control signal to a scan driving circuit and a sustain driving circuit (not shown). The scan driving circuit and the sustain driving circuit apply a sustaining pulse to the scan electrodes and the sustain electrodes of the PDP 38 during the sustain period in response to the
20 timing control signal from the waveform generator 38.

 In such a conventional PDP, a sustaining pulse calculated by the APL is applied to the discharge cells 1 irrespectively of a load of each sub-field. If a sustaining
25 pulse determined by the APL is applied irrespectively of a

load of each sub-field, then unnecessary power consumption occurs. For instance, when a full black is expressed at the panel 36, a discharge is not generated at each discharge cell 1 of the panel 38. However, the PDP has a problem in that, since a sustaining pulse is applied to each sub-field even in the above-mentioned case, power is unnecessarily wasted. In other words, the conventional PDP applies a sustaining pulse to a sub-field at which the sustain discharge is not generated, thereby causing a lot of power consumption.

Disclosure of Invention

Accordingly, it is an object of the present invention to provide an apparatus and method of driving a plasma display panel that is adaptive for reducing power consumption.

In order to achieve these and other objects of the invention, a driving apparatus for a plasma display panel, in which one frame has a plurality of sub-fields, according to one aspect of the present invention includes sub-field mapping means for mapping a data inputted from the exterior thereof onto a sub-field pattern stored in advance; an APL calculator for calculating an APL corresponding to said

data inputted from the exterior and generating an information about the number of sustaining pulses corresponding to the calculated APL; a load detector for receiving the mapped data from the sub-field mapping means
5 to generate a control signal in response to whether or not a data for each sub-field is supplied; and a waveform generator for controlling a sustaining pulse applied to a panel in response to said information about the number of sustaining pulses and said control signal.

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In the driving apparatus, the load detector generates said control signal in correspondence with a sub-field to which said data is not supplied, of the plurality of sub-fields.

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The waveform generator makes a control such that said sustaining pulse is not applied during a sustaining period of a sub-field corresponding to said control signal while said sustaining pulse is applied during sustaining periods
20 of the remaining sub-fields.

A method of driving a plasma display panel, in which one frame has a plurality of sub-fields, according to another aspect of the present invention includes the steps
25 of checking a specific sub-field to which a data is not

supplied from the plurality of sub-fields; and making a control such that a sustaining pulse is not applied during a sustain period of the specific sub-field.

5 In the method, said sustaining pulse is applied during sustain periods of the remaining sub-fields other than the specific sub-field.

 According to the present invention, a sustaining pulse
10 is not applied during a sustain period of a sub-field to which a data is not supplied, so that it becomes possible to prevent an unnecessary waste of power.

Brief Description of Drawings

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 These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings, in which:

20 Fig. 1 is a schematic plan view showing a configuration of a conventional plasma display panel;

 Fig. 2 is a detailed perspective view showing a structure of the cell shown in Fig. 1;

 Fig. 3 is a block diagram showing a configuration of a
25 driving apparatus for the conventional plasma display

panel;

Fig. 4 is a block diagram showing a configuration of a driving apparatus for a plasma display panel according to an embodiment of the present invention; and

5 Fig. 5 and Fig. 6 depict a sustaining pulse controlled by the driving apparatus shown in Fig. 4.

Best Mode for Carrying out the Invention

10 Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Hereinafter, the preferred embodiments of the present
15 invention will be described in detail with reference to Figs. 4 to 6.

Fig. 4 is a block diagram showing a configuration of a driving apparatus for a plasma display panel according to
20 an embodiment of the present invention.

Referring to Fig. 4, the PDP driving apparatus according to the embodiment of the present invention includes a gain adjuster 42, an error diffuser 43 and a
25 sub-field mapping unit 44 that are connected between a

first inverse gamma adjuster 41A and a data aligner 45, and an average picture level (APL) calculator 47 connected between a second inverse gamma adjuster 41B and a waveform generator 48, and a load detector 46 connected between a
5 sub-field mapping unit 44 and a waveform generator 48.

Each of the first and second inverse gamma adjusters 41A and 41B makes an inverse gamma correction of digital video data RGB from an input line 40 to thereby linearly
10 convert brightness according to gray level values of image signals.

The gain adjuster 42 adjusts an effective gain for each of red, green and blue data to thereby compensate for
15 a color temperature.

The error diffuser 53 diffuses a quantization error of the digital video data RGB inputted from the gain adjuster 52 into the adjacent cells to thereby make a fine control
20 of a brightness value.

The sub-field mapping unit 44 maps a data from the error diffuser 53 onto a sub-field pattern stored in advance for each bit, and applies the mapped data to a data
25 aligner 55.

The data aligner 45 applies digital video data inputted from the sub-field mapping unit 44 to a data driving circuit of the panel 49. The data driving circuit
5 is connected to the data electrodes of the panel 49 to latch a data from the data aligner 45 for each one horizontal line and then apply the latched data to the data electrodes of the panel 49 for each one horizontal period.

10 The APL calculator 47 calculates an average brightness per frame, that is, an average picture level (APL) with respect to digital video data RGB inputted from the second inverse gamma controller 41B, and outputs information about the number of sustaining pulses corresponding to the
15 calculated APL.

The load detector 46 generates a control signal in correspondence with a load of a data mapped by the sub-field mapping unit 44, and applies the generated control
20 signal to the waveform generator 48. In real, the load detector 46 determines whether or not a data is supplied for each sub-field. If a data is supplied to the sub-field, then the load detector 46 generates a control signal to apply it to the waveform generator 48. In other words, the
25 load detector 46 detects a sub-field to which a data is not

supplied (or a sub-field in which a sustain discharge is not generated), and generates a control signal in correspondence with the detected sub-field.

5 The waveform generator 48 generates a timing control signal in response to the information about the number of sustaining pulses from the APL calculator 47, and applies the timing control signal to a scan driving circuit and a sustain driving circuit (not shown). The scan driving
10 circuit and the sustain driving circuit apply a sustaining pulse to the scan electrodes and the sustain electrodes of the panel 49 during the sustain period in response to the timing control signal from the waveform generator 57.

15 Meanwhile, the waveform generator 48 controls the scan driving circuit and the sustain driving circuit such that, when a control signal is inputted from the load detector 46, a sustaining pulse is not applied during the sustaining period of the sub-field corresponding to the control signal.
20 In other words, the waveform generator 48 controls them such that a sustaining pulse is not applied during the sustain period of the sub-field corresponding to a control signal from the load detector 46, thereby preventing an unnecessary power consumption.

An operation procedure of the load detector 46 and the waveform generator 48 will be described in detail with reference to Fig. 5 below.

5 First, it is assumed that a data is not supplied to the fourth sub-field SF4 while a data is supplied to the remaining sub-fields SF1 to SF3 and SF5 to SFk in Fig. 5.

In the reset period included in each sub-field SF, a
10 predetermined initializing pulse is applied to the scan electrode to thereby initialize the discharge cell. In the address period, a data pulse corresponding to the data is applied to the address electrode to thereby select a discharge cell to be turned on. Further, in the sustain
15 period, a sustaining pulse corresponding to the APL is applied to cause a sustain discharge at the discharge cells selected in the address period.

The load detector 46 refers a data mapped for each
20 sub-field to generate a control signal. Herein, since a data is not supplied only during an interval of the fourth sub-field SF4, the load detector 46 generates a control signal in correspondence with an interval of the fourth sub-field SF4. The waveform generator 48 controls the scan
25 driving circuit and the sustain driving circuit to apply

sustaining pulses having the number corresponding to the APL during the sustain period. Further, the waveform generator 48 controls the scan driving circuit and the sustain driving circuit such that a sustaining pulse is not applied during a time interval of the sub-field corresponding to a control signal from the load detector 46, that is, the fourth sub-field SF4. Thus, a sustaining pulse is not applied in the sustain period of the fourth sub-field SF4, so that it becomes possible to prevent an unnecessary power consumption. In real, in the embodiment of the present invention, when a full black is expressed during one frame at the panel 49, a sustaining pulse is not applied during the sustain periods of all the sub-fields SF included in said frame as shown in Fig. 6.

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Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.

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